Rules and Technical Requirements

1 MR. FAGAN: Instead of briefing all of the rules

3 here, because I have only got a half an hour, you can see for

4 yourself that in the rules, there are rules that you are

5 required to follow or there might be penalties, and then

6 there are other things that you could consider procedures

7 that are not necessarily disqualifying or penalized, but

8 procedures that are just things that make everything run

9 smoother.

10 So, here, I only want to talk about those rules

11 that might influence somebody in terms of participating in

12 the Grand Challenge. The procedures, you know, what color

13 your number has to be painted on the side of the vehicle, I

14 mean that is not something that we need to worry about right

15 now.

16 These rules are for discussion. The set of rules

17 that is on the web site, the set of rules that you have in

18 your bag and in your folders are for discussion, they aren't

19 necessarily the official rules, and that is all in italic

20 letters at the top of the papers that you got.

21 It is very important for everybody to know that as

22 these rules are the discussion version of rules, we are

1 interested in your feedback. We don't want to write any

2 rules that restrict the innovative and breakthrough thinking

3 in terms of offering technical solutions for military utility

4 in terms of autonomous vehicles.

5   In developing the rules, this was the precedence --

6 Certainly, safety is absolutely number one, not only for the

7 Challenge vehicles themselves, but for the safety vehicles

8 and the occupants of those vehicles.

9   The number two priority is legal compliance. We

10 are dealing with a lot of land use authorities and we want to

11 make sure that we are totally in compliance with all of their

12 requirements regarding the use of their land for this Grand

13 Challenge.

14   Third, is fairness. We want to make sure that

15 everybody has a fair chance at this, that the rules are

16 written that way, so as we discover loopholes or if any of

17 you discover loopholes -- I know early when this thing was

18 announced, there were some people that wanted to mount

19 cannons on top of their vehicles and shoot the other

20 vehicles, and we didn't think that was fair, so we have got a

21 rule now that prohibits that.

22   And then Challenge goals. Now, let's everybody

remember that what we are trying to do here is to accelerate

the research and development necessary for highly capable

autonomous ground vehicles. So, some of the solutions that I

have heard are really, really good solutions, some of them

are very innovative, and many of them have good military

utility. Some of them don't have military utility, though,

and so we have written rules to only encourage that type of

research and development and technical solutions that do have

military utility.

Lastly, efficient operations. We might have

written some rules that just simply make it easier for the

Grand Challenge staff to conduct this.

Rule No. 1, which is at the bottom, is that the

rules will change. I just described that to you. We are

going to put another set of rules up on the web site on April

the 1st.

All right. One question that everyone wants to

know is who is eligible to be in this. In order to lead a

team, whether an organization, a university, or a person, you

need to be a U.S. university, U.S. organization, or U.S.

person in order to lead the team.

FFRDCs who want to lead teams can do so. They

1 can't use any federal money specifically for developing or

2 participating, developing any capability or participating in

3 the Grand Challenge.

4   Federal employees, and I have met some who are here

5 today, a lot of people like to do this, perhaps they do it in

6 their work, perhaps they do it as a hobby, they are eligible,

7 but they have to do it on their own time. Now, that's the

8 team lead.

9   Team members can be any of the above. In addition,

10 foreign entities can be team members. These bullets that you

11 are going to see on my charts are covered in more detail in

12 the package of the conference rules that you have in your

13 package.

14   Sponsorship. Now, last night as we were stuffing

15 everybody's name tag into the folders, I noticed that there

16 were seven people who signed up to come to the conference who

17 registered as sponsors. Now, people are interested and

18 companies are interested in sponsoring the Grand Challenge

19 for different reasons, and there are different terms and

20 conditions that they might have for sponsoring.

21   Some might want to sponsor all comers, some might

22 want to sponsor one vehicle. Sponsorships can, you know,

what the sponsors provide might vary. I didn't see anybody

walking around with a big, black bag full of cash here, but

we are still looking for those.

But let me just ask, because I know of only seven

name tags that had sponsor on them, can I just ask for anyone

who is registering as sponsor and agrees to, want to stand up

and just wave to everybody, so you all can see who they are.

All right. Let me remind everybody these people

have not just come here with a bag of money, okay. They are

interested in sponsoring for different reasons, so it is up

to you to find out what those reasons are.

DARPA is not going to provide any blanket

sponsorships. DARPA is not going to go out and buy everybody

a set of tires or give everybody a humvee to build or

anything like that.

Teams can secure their own sponsors. Many of you

have already started doing that, and that seems to be working

for a lot of the prospective competitors.

Okay. Insurance. Now, we have gotten an awful lot

of questions on insurance, so we had a pre-meeting yesterday

and discussed this a lot. This is where we are right now.

There is going to be, as I said, a Q&A later on, after a

1 couple of more briefs, I believe, there is going to be a Q&A,

2 we are going to discuss insurance, but right now this is

3 where we are.

4   Everybody on the team, all of your vehicles and

5 anything that you bring with it has to be covered -- personal

6 injury to your team members, to anybody else that you might

7 whack as you are driving through the desert, injury to the

8 property of others, environmental damage along the route.

9   Now, you know, we are not talking about dandelions

10 and stuff like that. We are talking about the land use

11 authorities are going to give us rules, and as we get those,

12 of course, we only get the rules when we tell them where we

13 want to go and we don't know that yet, but I am sure we are

14 going to have restrictions.

15   We will certainly, as quickly as possible, get

16 those out to everybody, so they know the restrictions under

17 which they are supposed to operate. Whether you cover your

18 own vehicles is up to you, but you have seen that there is a

19 chance that you might be in some hazardous areas where if

20 your vehicle doesn't exhibit intelligent behavior, you know,

21 it could go off of a cliff. Now, that is up to you whether

22 you want to insure it.

1   Now, if there is somebody at the bottom of the

2   cliff that gets hit by it, that needs to be insured. You

3   don't need to cover government equipment. We just hope you

4   don't hit any of our stuff, but, you know, we are

5   self-insured, and we will post information and names of

6   insurance providers.

7   I know that many teams have talked to me and told

8   me that they are having trouble getting hold of insurance

9   companies. We have been conducting our own survey, and we

10 seem fairly confident that we are going to be able to get

11 some folks together, perhaps have a thread on the forum where

12 people can discuss insurance and talk amongst yourselves

13 where you have had some success in contacting insurance

14 companies.

15   Further, later on this afternoon, up in the Teaming

16 Forum, that is up on the fourth floor out in the Conner

17 Pavilion, there will be a table set aside to ask insurance

18 questions and to swap information about insurance with other

19 prospective participants.

20   All right. Challenge vehicle. Some folks want to

21 have more than one Challenge vehicle. That's okay, it's just

22 you have got to have two teams. It can be the same team

1 leader, but you have got two teams, you have got two team

2 names, you have got two team vehicles. All right. No more

3 than one vehicle per team.

4   It must be a ground vehicle propelled and steered

5 principally by resistance with the ground, so that would be

6 legs, pogo sticks, hoppers, wheels, treads, whatever you

7 want. We are not looking for aviation type of vehicles.

8 This needs to be a ground vehicle.

9   Unitary system. There was some discussion by Dr.

10 Fish about autonomous vehicles that use an unmanned air

11 vehicle to go out forward and sense. That is not permitted

12 in this case. Everything has got to be hooked together when

13 you cross the departure line, and it has got to be hooked

14 together when you get to the arrival area, and we have got a

15 rule if anything falls off, I will show you that in a second.

16   There are no physical limits in terms of the size

17 of your power plant or the size of your tires or the size of

18 your vehicle. Now, you saw that you might encounter

19 underpasses that are 10 feet by 9 feet. If you want to have

20 a 15-foot wide vehicle, that's okay if it's, you know, got

21 some octopus qualities that it can shrink down and get

22 through and then spread out.

1   We don't want to restrict. I am just telling you

2 it has got to fit through that hole. However you want to

3 handle that, that is up to you, but we haven't restricted the

4 size of this thing.

5   Keep in mind that you are going to need to probably

6 put it on a tractor-trailer, you know, to get it from one

7 spot to the other. I know you guys are smart enough to

8 figure that out, unless you want to assemble it I guess in

9 the area, the departure area.

10   It may not violate land use restrictions. We are

11 going to get those and as soon as we get them, as I said, we

12 will pass them out.

13   No classified data or equipment. If any of you are

14 working on government projects and you have access to

15 classified imagery or classified land characterization data,

16 you can't use that, and no equipment that is classified.

17   Hazardous approaches may not be permitted. That is

18 why you are writing a technical paper. Dr. Mulqueen is going

19 to get up in a second and talk about the technical paper

20 requirements, so I will leave that for him.

21   Autonomous intelligent behavior is required. I am

22 sure just about everybody is going to have some sort of

1 position determination system on there, such as GPS. The

2 signals that you use need to be freely available to

3 everybody, whether you use Loran or GPS or you hone in on

4 some radio station or something.

5 If you want to use some sort of position

6 determination system that is not freely available to the

7 public, you need to get approval to do that, and if DARPA

8 does issue approval for you to do that, then, the committee

9 is probably going to notify all the other teams of the

10 availability of that, so that everybody else has a chance to

11 take advantage of it, as well.

12 GPS alone is not going to be sufficient. That has

13 been said a couple of times today. This is one of Sal's

14 charts or pictures. If, for example, a way point -- I am

15 pointing below here, but I hope everybody can see where this

16 dot is -- for example, if a way point was set here, and the

17 next way point was, I don't know, over there or over here,

18 for example, depending on what the route boundary is that we

19 have been given by the land use authorities, the vehicle may

20 just decide to go in that direction if it is permitted, you

21 know, if you have the lateral boundaries to permit it, which

22 may not be an efficient way to do this.

1   I mean it might be far more efficient just to

2 follow this around and then down to the next way point. So,

3 the course is going to be constructed, so that intelligent

4 behavior will be required to successfully complete the

5 course. GPS is just going to help you to get to the

6 waypoints.

7   The safety vehicle. It can be a ground vehicle or

8 it can be an aviation vehicle. It is going to be pretty

9 dangerous following these robots around, and that is one of

10 our top concerns. I said earlier that safety is the number

11 one priority here as we make up the rules.

12   Ground vehicles have to meet safety requirements

13 that SCORE International uses for their off-road races

14 because it could be that people are going to be getting up to

15 some pretty high speeds here, and we are going to publish

16 those. In fact, I understand that there is a draft of those

17 out right now, but if you can go to the SCORE web site, they

18 have their rule book, and you can see what all the safety

19 requirements are for their class of vehicles.

20   There is more information in the pack. What it

21 says is to meet the safety requirements for any class of

22 vehicle except ATVs or motorcycles.

1   Ground vehicles for use as safety vehicles do not

2   need to be street legal. You have got to have two people in

3   there at least, in fact, two might be a better solution

4   because the third person might be bouncing around quite a

5   bit.

6   The team driver/pilot, the person from the team, is

7   the person responsible for the safe operation of the

8   Challenge vehicle. If you want to put an extra person in

9   there, then, you can decide who that is, but the person that

10 is responsible for the safety of the Challenge vehicle is not

11 the DARPA field judge that is in the safety vehicle.

12   The DARPA field judge is there for judging, to

13 watch lateral boundaries, to make sure you went through the

14 waypoints, and also to augment the safety observation of the

15 team driver or if there is a team observer in there, as well.

16   The safety vehicle can't lead the Challenge

17 vehicle. I mean you can see why that rule is written. We

18 don't want the safety vehicle out in front and the bot just

19 follows it.

20   It is okay to swap safety vehicles and people.

21 There is going to be at least one checkpoint where there is a

22 20-minute stop. If you want to switch vehicles and switch

1 people, you can do that. We are considering that there might

2 be some other opportunities along the route.

3   In the current version of the rules permit the

4 swapping of a safety vehicle at any point along the route,

5 and there are several convenient places. We will try to make

6 sure that there are several convenient places along the route

7 where that can be done if you feel that you want to do that

8 before or after the checkpoint.

9   Speed limits. When I made this slide, it was a

10 definite possibility, now you can strike out where it says

11 "possibility." There will be some speed limits, but there

12 will also be plenty of opportunities to go just as fast as

13 you can get going. The speed limits will be imposed most

14 likely by the land use authorities who have given us

15 permission to use this land, and we want to make sure we

16 don't violate any of those limits.

17   Non-team vehicles on the route. Right now you can

18 have your Challenge vehicle and you can have your safety

19 vehicle on the route. If there is some reason that you need

20 another vehicle on the route, if one of your sponsors, for

21 example, wants to film it or something, you have got to come

22 to us and get permission.

1   We are right now not inclined to permit that

2 because of the safety considerations, but you need to come

3 talk to us. Right now it is not permitted, but we will

4 listen to you.

5   Lateral boundaries. Again, they are designed to

6 comply with safety and land use authorities. In terms of

7 safety, I will remind you again about that one picture that

8 you saw, that if the vehicle goes off to the right, it is

9 going to go off the cliff. Okay, that is a safety problem,

10 you don't know who is at the bottom of that cliff, but I

11 mean, maybe they will hear the vehicle coming.

12   And then land use authorities, they are going to

13 give us a trail to be on or some area to be on, and they

14 might give us plus or minus, I don't know, 2 meters, 7 meters

15 or a kilometer. Anyway, we will provide that information to

16 you.

17   Passing. No vehicle can intentionally hinder

18 another vehicle from passing. Remember that there is going

19 to be a DARPA field judge in each of the safety vehicles that

20 will be watching for this. Passing is okay if you just stay

21 within the boundaries. I mean all of this is pretty

22 self-explanatory. I am just reading you my own slide here.

1   But if you are in an area where you can't get

2 around, if a particular area has a short stretch or it

3 doesn't matter how long a stretch is, any stretch of trail or

4 graded road or anything that is too narrow to permit passing,

5 and you find, the bot finds itself behind a slower vehicle

6 and it wants to go around, as long as that slower vehicle is

7 moving, right now it's just tough luck. You wait until the

8 road widens out and you can get around. You are not

9 permitted to go outside the boundary.

10   If that bot is dead and when you come up on it, it

11 is not moving, the field judge is going to check his watch,

12 and 10 minutes later, if the bot hasn't moved, it's

13 disqual'd, okay. We are figuring 10 minutes is enough time

14 for any kind of processor to reboot or for the bot to get

15 smart again and get on the road, but if is doesn't, then, the

16 team is disqual'd for that bot, and we will put it in neutral

17 gear, and we will push it off, and everybody else can go by.

18   The time that everybody spent waiting for the 10

19 minutes for the BOT to get smart again and get going plus the

20 time to get it off the road, that's all credited to your

21 elapsed time -- I am sorry, your corrected time.

22   Safety vehicles have to give way, but you are not

1 obligated to go off, outside the boundary in order to give

2 way.

3   Physical contact. Everybody knows this rule. You

4 can't touch the vehicle, you can't cause the vehicle to be

5 touched. You can't pour gasoline in the vehicle. If you are

6 going to refuel, it has all got to be done autonomously.

7   It is prohibited on the route and in the checkpoint

8 area. In terms of the route, there is the departure area

9 where you can fix your BOT, do whatever you want. There is

10 the arrival area. Once you get in there, the Challenge is

11 over for you. There is the route, there is a checkpoint

12 area.

13   On the route, it is totally autonomous. In the

14 checkpoint area, if you are going to do autonomous

15 maintenance or refueling, you can do a little bit of

16 telemetry to get lined up with whatever equipment is going to

17 service your vehicle, but you can't touch it in any case.

18   Jettisoning material. Now, I am not talking about

19 soot, okay. I am talking about, you know, things that used

20 to be on the vehicle that aren't on the vehicle anymore, like

21 empty fuel cells or fuel bladders, you are not allowed to

22 jettison any of that on the course.

1   If you do, it is going to be penalized, possibly a

2 disqual, but if you have got plans to do that, you know, we

3 will see it in the tech paper, and, of course, if your

4 vehicle shows up and it is not in compliance with the tech

5 paper, that will be a problem, too.

6   Now, if you have unintentional jettisoning -- that

7 happens to my old car all the time -- you know, that is okay,

8 so your mirror falls off or something, all right, no big

9 deal. Stop the safety vehicle, pick up the mirror, put it in

10 there. As long as you have got all the gear together when

11 you cross the arrival line, it's okay.

12   Let's see, where are we. Departure time limit. All

13 right. Every vehicle is going to have a start signal. Don't

14 know yet, don't know how many people are going to be there,

15 whether it is going to be everybody at once or it's going to

16 be a staggered start, but everybody is going to have a start

17 signal.

18   When that start signal goes off to leave the

19 departure area, you have got one hour to clear the departure

20 area. If your BOT isn't ready yet, okay, you have got an

21 hour. After the hour is up, that's it, you are disqual'd.

22   Maximum finishing time. Everybody wants to know

1 this. Well, right now it's not going to be any less than 6

2 hours. We had to give everybody a number because everybody

3 wanted a number. Right now it's 6 hours, that's what you

4 have got.

5   Now, once we figure out the exact route, there are

6 folks that go survey routes all the time trying to decide the

7 best route to use. Once this has been decided, then, we will

8 have a better feel for what the maximum finishing time will

9 be. It will not be less than 6 hours. It may be after we

10 find a route, that we are going to have to adjust that time.

11   Ten hours total to complete the route -- by the

12 way, that 6 hours is corrected, okay, so right off the bat,

13 you know, you have got your 20-minute checkpoint to add to

14 that, and any time that you have spent behind a disabled

15 vehicle, et cetera, et cetera, plus any penalty time that

16 gets added on to your corrected time -- 10 hours total to

17 complete the route. For safety reasons, we don't want

18 anybody driving around at high speeds in the safety vehicles

19 at night. We want to make sure we get to Vegas before dark.

20 That is the reason for that one.

21   E-stop. There has to be two kinds of E-stop,

22 manual and wireless. Manual, it's in the rules, I won't go

through all the details there. There needs to be some

buttons or handles on the sides of your vehicle with

labeling, so that if the vehicle starts doing uncommanded,

undesirable behavior, you can get the vehicle stopped.

In addition to that, there needs to be a wireless

E-stop that maintains a link to the BOT, so the BOT is

receiving a signal. If the BOT doesn't receive the signal,

the Challenge vehicle has to come to a complete stop.

As soon as the signal is reestablished, it needs to

be able to start itself and get going. You can't go touch

the vehicle and reboot anything manually. It has got to

figure this out once it receives the signal again and get

going again.

The link could be interrupted by line of sight --

maybe the vehicle just gets too far in front of you, goes

around something. Or perhaps it's a manual interruption,

somebody in the safety vehicle observes something, that there

is a good reason to stop the vehicle, it could be a safety

reason, either safety of somebody else, a Winnebago wanders

into the middle of the course or something like that. Or,

well, it could be just about any kind of reason.

Now, if the vehicle -- the field judge can order an

E-stop, and the orders of the field judge in the safety

vehicle must be complied with. If the field judge orders an

E-stop for safety reasons, where, you know, there is

something that could get damaged, that the bot is headed for,

and it is not undesirable behavior of the bot, the net time

will be credit for you until that situation gets resolved.

However, if the bot is stopped because undesirable behavior

would have damaged the bot or it just did a 90-degree turn

and just took off, that is a disqual, because that is manual

control of the vehicle.

Time credit. I already said that neutral gear

capability. I talked about an immobile vehicle that is

immobile for 10 minutes, it is disqualified. We need to be

able to quickly get that vehicle into neutral and either get

it pulled or pushed off the course. I mean if it's

disqual'd, you can touch it, right. So, we need to be able

to get that thing into neutral quickly and can find some way

to get it off the route, so everybody else can get by.

The Checkpoint -- to accomplish autonomous

refueling or autonomous servicing of your vehicle, not

required.

Manual control behavior is not permitted. You are

not allowed to tele-operate your vehicle into the pit. It

needs to find it itself.

And if you are not going to do autonomous serving

and refueling, then GPS Navigation will take you to your

designated area where your challenge vehicle is going to

stop, safety vehicle pull up right behind, go off, come back,

20 minutes later get going.

Okay. Route rules, waypoints. I say approximately

a thousand. I haven't been on the survey team drives, but

that is what I am understanding, it is about a thousand

waypoints.

A lot of reasons to have waypoints. Safety, of

course, is one of them. Keep the vehicles in compliance with

land permits. Another reason to have waypoints is to make

sure that if it is a trail that you are supposed to stay on

-- sometimes you don't have to stay on the trail, as I told

you earlier. If there is an S-turning trail and the

waypoints at the other end, it is up to the bot to figure,

well, do you want to follow the trail, will that be faster

for you, or just cut straight across all the berms and

everything. But there will be lateral boundaries on parts of

the course and the waypoints will help you keep within those.

1   There are many other purposes, like to present

2 vehicles with obstacles. The deal is here that the waypoints

3 will deliberately be chosen to present a challenging route

4 for the vehicles. So, if I had to go from here to the other

5 side of the room, that is too easy. That is a straight shot.

6 I will probably send the vehicle on the other side of that

7 pillar first and then over to the other side of the room.

8 That is another reason to have waypoints.

9   Provide mandatory time limits. The waypoints will

10 be kept open for certain time periods. Not every waypoint is

11 going to have a time limit. There will just be a few of

12 them, but if your challenge vehicle doesn't get halfway

13 through the course and it is 8:30 at night, you are probably

14 not going to finish unless you can do 300 miles an hour for

15 the rest of the course. So we are going to close these

16 waypoints down in sequence, but the time we give you before a

17 close-down, it is going to be far more time, it is going to

18 be generous. But there is just no point in keeping that

19 waypoint open all the time and paying the police to keep all

20 the traffic away.

21   To find the endpoints of the route, that is pretty

22 obvious.

1   Vehicles have to pass through each waypoint.

2 Everybody knows there is an error circle around GPS

3 waypoints. We are going to figure out what that error circle

4 is and make sure that it is achievable. We are not going to

5 make those circles so small that it is just not possible to

6 do that.

7   Not all waypoints will be visibly marked. We are

8 going to find some environmentally friendly way so that those

9 way points that are marked can be discerned by the field

10 judge. When the challenge vehicle comes up to those points,

11 the field judge can figure he was within the circle, he was

12 close enough to the waypoint.

13   The waypoint data, you heard before is going to be

14 given to you 2 hours before the start. I have got a slide

15 that is going to show you the format in which that waypoint

16 data will appear.

17   Waypoint navigation is not sufficient. For

18 example, if your GPS gives you 7-foot accuracy, a 14-foot

19 circle, it might be that the trail you are on is only a

20 10-foot trail, and that is why intelligent behavior and

21 sensing is going to be required. GPS navigation, if that is

22 all you have, it is just not going to work for you.

1   I know you can't read this, but it will show up on

2   the web. What we want to know is what format do most of the

3   prospective participants want to see their way point data,

4   and the majority rules. We are only going to provide it in

5   one form. Everybody else is going to have to convert. So

6   this is just something we threw together.

7   It is basically for each way point, the latitude,

8   the longitude, the way point number, of course, the speed

9   leaving that way point, the maximum you are allowed to go. I

10   mean, 200 we'll make it 500, if anybody thinks they can go

11   faster than that.

12   Left lateral boundary, right lateral boundary, and

13   if it is a timed way point -- for example, this is just

14   notional, but, for example, way point No. 25, anybody that

15   hasn't got to way point No. 25 in an hour has to be removed

16   off the route.

17   That is all I have for the rules. I will turn it

18   back over to Colonel Negron.

19   [Applause.]

20   COL NEGRON: You know, the beauty about these

21   rules, they always can be changed. We have got a lot of

22   comments out there about 6-hour time, and I understand it is

1 very difficult.

2   So we are going to put our first waiver in here,

3 and we are just going to say the faster the vehicle can

4 complete the route there in 10 hours, then we will keep

5 adjusting. Remember, these are preliminary rules. We need

6 your feedback. I have heard a lot of people talking about 6

7 hours, pretty tough. So our first waiver is 10 hours to

8 complete the route. The first vehicle to be inside that 10

9 hours will win the prize. I think that is pretty acceptable

10 to everybody.

11   If you are not, come see me after the break. I am

12 trying to be as generous as I can.

13   All right. Let me move on here. Three other

14 things. We are going to have a Q&A right after this. There

15 are 3-by-5 cards that have been provided in your package, I

16 believe on the left side. So, if you have got questions,

17 please write them down. We are going to use the two center

18 mics, and we will have them read the questions. Please turn

19 the cards back in to Kimberly and Johanna who are going to

20 collect them, and we are going to answer those questions back

21 on the web.

22   A question about rosters, will we get a roster.

1 You will receive a roster this afternoon from everybody who

2 has registered. So we will get those printed and passed out.

3   Second chances, of course, tap into our website.

4   At this time, I would like to introduce Dr. Michael

5 Mulqueen. He is going to talk about the technical

6 application and some of the details that you will be

7 required.